Unit 9 Review - Stoichiometry

LT1: I can use a balanced equation to determine the ratio between chemicals in a reaction

1. Balance the following equation:

$\underline{2}\ C_2H_6 + \underline{7}\ O_2 \rightarrow \underline{4}\ CO_2 + \underline{6}\ H_2O$

a. How many moles of C-2-H_6 are used when 16.54 moles of carbon dioxide are produced?

$$16.54\text{ mol }CO_2 \times \frac{2\text{ mol }C_2H_6}{4\text{ mol }CO_2} = 8.270\text{ mol }C_2H_6$$

b. How many moles of O_2 are needed to react with 5.47 moles of C_2H_6?

$$5.47\text{ mol }C_2H_6 \times \frac{7\text{ mol }O_2}{2\text{ mol }C_2H_6} = 19.1\text{ mol }O_2$$

LT2: I can convert from grams/particles/liters of a substance to grams/particles/liters of another

c. Using the equation above, how many grams of oxygen gas are needed to make 8.640 grams of water?

$$8.640\text{ g }H_2O \times \frac{1\text{ mol }H_2O}{18.02\text{ g }H_2O} \times \frac{7\text{ mol }O_2}{6\text{ mol }H_2O} \times \frac{32.00\text{ g }O_2}{1\text{ mol }O_2} = 17.90\text{ g }O_2$$

d. How many liters of oxygen at STP are needed to make 32.14 moles of carbon dioxide?

$$32.14\text{ mol }CO_2 \times \frac{7\text{ mol }O_2}{4\text{ mol }CO_2} \times \frac{22.4\text{ L }O_2}{1\text{ mol }O_2} = 1260.\text{ L }O_2$$

2. Write out the correct balanced equation: ammonium sulfide reacts with copper (II) nitrate in a double replacement reaction to produce ammonium nitrate and copper (II) sulfide.

$$(NH_4)_2S + Cu(NO_3)_2 \rightarrow 2NH_4NO_3 + CuS$$

a. How many moles of ammonium nitrate are produced from 5.22 grams ammonium sulfide?

$$5.22\text{ g }(NH_4)_2S \times \frac{1\text{ mol }(NH_4)_2S}{68.17\text{ g }(NH_4)_2S} \times \frac{2\text{ mol }NH_4NO_3}{1\text{ mol }(NH_4)_2SO_4} = .153\text{ mol }NH_4NO_3$$

b. How many grams of copper (II) sulfide are produced along with 13.88 grams of ammonium nitrate? $13.88\text{ g }NH_4NO_3 \times \frac{1\text{ mol }NH_4NO_3}{80.06\text{ g }NH_4NO_3} \times \frac{1\text{ mol }CuS}{2\text{ mol }NH_4NO_3} \times \frac{95.62\text{ g }CuS}{1\text{ mol }CuS} = 8.289\text{ g }CuS$

LT3: I can determine the limiting reactant and theoretical yield

3. Nitrogen reacts with magnesium to produce magnesium nitride. Write the balanced equation.

$$N_2 + 3Mg \rightarrow Mg_3N_2$$

a. What is the theoretical yield of when 5.00 g of magnesium is reacted with 25.0 g of nitrogen gas? TY

$5.00\,g\,Mg \times \frac{1\,mol\,Mg}{24.31\,g\,Mg} \times \frac{1\,mol\,Mg_3N_2}{3\,mol\,Mg} \times \frac{100.95\,g\,Mg_3N_2}{1\,mol\,Mg_3N_2} = 6.92\,g\,Mg_3N_2$

$25.0\,g\,N_2 \times \frac{1\,mol\,N_2}{28.02\,g\,N_2} \times \frac{1\,mol\,Mg_3N_2}{1\,mol\,N_2} \times \frac{100.95\,g\,Mg_3N_2}{1\,mol\,Mg_3N_2} = 90.1\,g\,Mg_3N_2$

LT4: I can determine the percent yield.

4. A large amount of heat is generated by the following reaction, so the water produced from the reaction usually driven off as steam. Some liquid water may remain, however, and it may dissolve some of the desired calcium chloride. What is the percent yield if 155 g of calcium carbonate is treated with 250. g of anhydrous hydrogen chloride and only 142.00 g of calcium chloride is obtained?

$$CaCO_{3(s)} + 2HCl_{(s)} \rightarrow CaCl_{2(s)} + CO_{2(g)} + H_2O_{(g)}$$

TY

$155\,g\,CaCO_3 \times \frac{1\,mol\,CaCO_3}{100.09\,g\,CaCO_3} \times \frac{1\,mol\,CaCl_2}{1\,mol\,CaCO_3} \times \frac{110.98\,g\,CaCl_2}{1\,mol\,CaCl_2} = 172\,g\,CaCl_2$

$250.\,g\,HCl \times \frac{1\,mol\,HCl}{36.46\,g\,HCl} \times \frac{1\,mol\,CaCl_2}{2\,mol\,HCl} \times \frac{110.98\,g\,CaCl_2}{1\,mol\,CaCl_2} = 380.\,g\,CaCl_2$

$\% = \frac{142.00}{172} \times 100 = 82.6\%$

5. Balance the following equation;

___ SiO_2 (s) + 6 HF (aq) → ___ H_2SiF_6 (aq) + 2 H_2O (l)

a. What is the theoretical yield in grams of hexafluorosilic acid (H_2SiF_6) produced when 40.0 grams of silicon dioxide are mixed with 40.0 grams hydrofluoric acid?

$40.0\,g\,SiO_2 \times \frac{1\,mol\,SiO_2}{60.09\,g\,SiO_2} \times \frac{1\,mol\,H_2SiF_6}{1\,mol\,SiO_2} \times \frac{144.11\,g\,H_2SiF_6}{1\,mol\,H_2SiF_6} = 95.9\,g\,H_2SiF_6$

$40.0\,g\,HF \times \frac{1\,mol\,HF}{20.01\,g\,HF} \times \frac{1\,mol\,H_2SiF_6}{6\,mol\,HF} \times \frac{144.11\,g\,H_2SiF_6}{1\,mol\,H_2SiF_6} = 48.0\,g\,H_2SiF_6$ TY

b. What is the limiting reactant?

HF

c. If 45.8 g of hexafluorosilic acid are actually produced, what is the percent yield?

$\% = \frac{45.8}{48.0} \times 100 = 95.4\%$

6. Methyl alcohol (CH_3OH) is made by reacting carbon monoxide with H_2. If you start with 2.5 g of H_2 and 30.0 L CO, what mass of methyl alcohol could be produced?

a. What is the limiting reactant? $2H_2 + CO \rightarrow CH_3OH$

LR $2.5\,g\,H_2 \times \frac{1\,mol\,H_2}{2.02\,g\,H_2} \times \frac{1\,mol\,CH_3OH}{2\,mol\,H_2} \times \frac{32.05\,g\,CH_3OH}{1\,mol\,CH_3OH} = 20.\,g\,CH_3OH$ TY

$30.0\,L\,CO \times \frac{1\,mol\,CO}{22.4\,L} \times \frac{1\,mol\,CH_3OH}{1\,mol\,CO} \times \frac{32.05\,g\,CH_3OH}{1\,mol\,CH_3OH} = 42.9\,g\,CH_3OH$

b. What is the theoretical yield?

7. In a reaction of 15.3 grams of NaCl with 60.8 grams of $Pb(NO_3)_2$, how many grams of lead (II) chloride will be produced? $2NaCl + Pb(NO_3)_2 \rightarrow 2NaNO_3 + PbCl_2$

a. What is the limiting reactant?

$$15.3\,g\,NaCl \times \frac{1\,mol\,NaCl}{58.44\,g\,NaCl} \times \frac{1\,mol\,PbCl_2}{2\,mol\,NaCl} \times \frac{278.10\,g\,PbCl_2}{1\,mol\,PbCl_2} = \boxed{36.4\,g\,PbCl_2}\ \text{TY}$$

LR

$$60.8\,g\,Pb(NO_3)_2 \times \frac{1\,mol\,Pb(NO_3)_2}{331.22\,g\,Pb(NO_3)_2} \times \frac{1\,mol\,PbCl_2}{1\,mol\,Pb(NO_3)_2} \times \frac{278.10\,g\,PbCl_2}{1\,mol\,PbCl_2} = 51.0\,g\,PbCl_2$$

b. What is the theoretical yield?

8. Determine the percent yield for a reaction between 3.74 g of Na and excess O_2 to produce Na_2O_2. 5.32 g of Na_2O_2 is recovered. $2Na + O_2 \rightarrow Na_2O_2$

$$3.74\,g\,Na \times \frac{1\,mol\,Na}{22.99\,g\,Na} \times \frac{1\,mol\,Na_2O_2}{2\,mol\,Na} \times \frac{77.98\,g\,Na_2O_2}{1\,mol\,Na_2O_2} = 6.34\,g\,Na_2O_2$$

$$\%Y = \frac{5.32}{6.34} \times 100 = 83.9\%$$

9. How many moles of NH_3 will be produced when 8.94 mole of H_2O are produced according to the following reaction:

$Ce_2O_3 + 6NH_4Cl \rightarrow 2CeCl_3 + 3H_2O + 6NH_3$

$$8.94\,mol\,H_2O \times \frac{6\,mol\,NH_3}{3\,mol\,H_2O} = 17.9\,mol\,NH_3$$

$$2Cu + S \rightarrow Cu_2S$$

10. If 1 g Cu is heated with 1 g sulfur what is the percent yield if 1.0 gram of Cu_2S is obtained?

$$1g\,Cu \times \frac{1\,mol\,Cu}{63.55g\,Cu} \times \frac{1\,mol\,Cu_2S}{2\,mol\,Cu} \times \frac{159.17g\,Cu_2S}{1\,mol\,Cu_2S} = 1.25\,Cu_2S$$

LR TY

$$1g\,S \times \frac{1\,mol\,S}{32.07g\,S} \times \frac{1\,mol\,Cu_2S}{1\,mol\,S} \times \frac{159.17g\,Cu_2S}{1\,mol\,Cu_2S} = 4.96g\,Cu_2S$$

$$\%Y = \frac{1.0g}{1.25} \times 100 = 80\%$$

11.The actual yield will be greater than, less than, or equal to the theoretical yield? *Support your answer.*

Actual yield will be less than theoretical yield. There is usually some experimental error. Some chemical may have spilled, or there may have been a side reaction